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but all the men continued the usual college activities with no obvious reduction in stamina.

Two of the men had chronic bad noses. One was operated upon during the test and the other should have been. Aside from these two, the prevalence of colds during the period was about the same as with the other college students. During the study three men underwent ether narcosis for operations (on nose, foot, and hemorrhoids) and made rapid recoveries. One man at the lowest period of weight contracted what was diagnosed by three physicians as typhoid fever, although the final course of the disease seemed to leave the diagnosis somewhat in doubt. He ran a very high fever, and was critically ill for some time, but has made a complete convalescence and recovery and has returned to college.

The most noticeable discomfort experienced by the subjects was a feeling of cold, which it is only fair to say might be due in large part to the severity of the past winter. In general, notwithstanding the very great reduction in the metabolism (which we believe was due to the removal from the body of the stimulus to cellular activity of approximately 150 grams of 'surplus nitrogen'), the whole period of lowered food intake had no untoward effect upon the physical or mental activities of these men, and they were able to continue successfully their college duties.

The control squad, having demonstrated the absence of a seasonal variation in metabolism for about three months, were put for a period of three weeks upon a restricted ration of less than one-half their previous calorie consumption. In all details the picture exhibited by the first squad was strikingly duplicated by the second squad, although, as the loss in weight was obviously not so great (6% as compared with 12%) the phenomena were quantitatively somewhat less emphasized.

The entire research will be published in conjunction with our co-workers, Drs. Walter R. Miles, and H. Monmouth Smith, in a monograph of the Carnegie Institution of Washington in the near future.

EFFECTS OF A PROLONGED REDUCTION IN DIET ON 25 MEN

II. BEARING ON NEURO-MUSCULAR PROCESSES AND MENTAL CONDITION

By Walter R. Miles

Nutrition Laboratory, Carnegie Institution of Washington, Boston

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It is obvious that any adequate investigation of prolonged reduction in diet must include observations of the neuro-muscular processes and general mental condition of the individuals studied. In the low-diet research the psychological measurements were made at the Nutrition Laboratory on Saturday evenings and Sunday mornings when the men were in Boston for the bi-weekly group metabolism experiment in the large respiration chamber.

After a standard evening meal the subjects came to the laboratory and were available during a period of approximately four hours. Of this time about one hour was spent on measurements which could be given to the men as a group. This was done in the library where table space and other conditions were adequate. Particular attention was given to the matter of lighting. The men were assigned seats which they occupied at each session although it was not believed that one location in the room was more favorable than another for the group experiments. A considerable period was allowed for preliminary adjustments, announcements, questions and a general quieting of the men before beginning the evening session.

The first measurement was a test of accuracy or steadiness of movement in tracing between parallel lines with many right-angle turns. The tempo was set by the metronome beating half seconds. The subject was instructed to start at a signal, to avoid contact with the boundary lines, and to make one straight line for each beat of the metronome. Each contact with a boundary line was counted an error.

Other measurements which could be suitably given by the group method were: Discrimination for the pitch of tones, using tuning forks and resonators as source (150 judgments); discrimination and cancellation of specified number groups on a printed page of numbers, the task being to mark each pair of successive digits which, when added, equaled 11; the addition of one-place numbers arranged in columns of ten during a test period of ten minutes; and the memory span for lists of 4-letter English words pronounced in tempo and without stress.

Psychological measurements of men on reduced diet

Group Method:

1. Accuracy in tracing between irregular parallel lines.
2. Discrimination for the pitch of tones.
3. Discrimination for specified number groups on a printed page.
4. Addition of one-place numbers for a period of ten minutes.
5. Memory span for 4-letter English words.

Individual Method:

6. Strength of grip; hands tested alternately.
7. Changes in pulse rate occasioned by short periods of exertion.
8. Latency, amplitude and refractory period of the patellar reflex.
9. Reaction time for turning the eye to a new point of regard.
10. Reaction time for speaking 4-letter words.
11. Continuous discrimination and reaction in finding serial numbers.
12. Sensory threshold for vision.
13. Sensory threshold for electric shock.
14. Speed and accuracy of the eye movements.
15. Number of finger movements performed in ten seconds.
16. Efficiency in traversing a right-angle maze.
17. Speed and accuracy in performing certain clerical tasks.

The measurements taken by the 'individual method' employed much technical apparatus. The general nature of these observations is indicated above. The apparatus was distributed in three rooms, which opened off a common hallway, and with the aid of two assistants it was possible to make psychological measurements with four of our subjects at the same time, each man serving a total of about seventy minutes. The measurements were grouped according to expediency. Nos. 6, 11, 16 and 17 (strength of grip, finding serial number, traversing the maze, and the clerical tasks) were such that two subjects could work in one room without disturbing each other. Nos. 8, 10, and 15 (patellar reflex, word reactions, and finger movements) formed a convenient group for a second room, since they all relied on the Blix-Sandstrom kymograph for chronographic record. The thresholds for vision and electric shock were determined in the third room, the main psychological laboratory. In this room, also, the distinctive measurements for the morning sessions were made. These included Nos. 7, 9, and 14, i.e., changes in pulse rate with exertion, reaction time of the eye, and speed of eye movements, together with more determinations of strength of grip and finger movement speed.

Most of the techniques used in the low-diet research, particularly those given by the individual method, had been previously elaborated in connection with other problems with the object of securing measurements and procedures which could be repeated on the same individual without large practice changes. Great care has been taken to make the measurements as objective and free from personal bias as possible; it will be noted that most of them have a distinct physiological trend. The avoidance of all practice effect and influence from changes in interest and attention is an ideal which of course is never quite reached in psychological investigation; however, the fortnight interval between sessions was a favorable circumstance for minimizing these factors in the present work.

Careful instructions preceded each measurement, both group and individual, and it is a pleasure to record the remarkable coöperation and serious attitude of the men who served as subjects.

It has not been possible thus early to get all the data into final form for comparison. Pending this it is unwise to make dogmatic statements. Final results are available for some of the measurements and the samples given in the table are thought to be representative. Separate averages for the two groups of men are presented in parallel columns headed 'D. S.' (Diet Squad; these men were on low diet from October 4, 1917, until February 3, 1918) and 'C. S.' (Control Squad; these students continued their normal diet up to January 8, 1918, and were then on reduction until January 28, 1918). The values in black face type are under normal condition of diet.

Illustrative results from psychological measurements during prolonged reduction in diet

MEASUREMENTS	NO. 1 TRACING		NO. 4 ADDITION				NO. 6 GRIP		NO. 14 EYE MOVEMENTS		NO. 15 FINGER MOVEMENTS	
	Average errors per line		Total columns in 10 minutes		Per cent of error		Average kilos for both hands		Average time in sigma		Number in 10 seconds	
	D. S.	C. S.	D. S.	C. S.	D. S.	C. S.	D. S.	C. S.	D. S.	C. S.	D. S.	C. S.
Experiment lasted 4 months September 29, 1917, to February 3, 1918	5.7	5.6	47.3	47.5	21.5	19.7					68.7	66.0
	5.9	5.6	50.2	46.9	16.3	10.9	47.6	52.8	95	92	65.6	65.2
	6.0	4.6	51.4	48.7	19.0	7.8	48.1	54.3	97	96	66.6	65.6
	5.4	4.7	54.0	49.6	19.9	10.8	46.9	52.8	97	91	64.2	64.7
	5.3	4.8	52.6	42.5	15.1	9.6	45.7	53.5	98	92	64.3	66.5
	4.1	4.4	52.7	46.9	17.0	14.0	44.9	54.1	100	95	63.4	64.2
	4.7	3.5	52.8	48.7	18.4	10.7	46.2	53.2			64.9	62.4
	4.4	3.9	52.8	51.1	14.2	8.7	45.9	53.3			65.4	61.4
	3.3		53.4		13.2		45.8				63.5	
	3.3		56.8		11.7						67.6	

Accuracy of movement in tracing between parallel lines shows a gradual improvement as the experiment progresses. The diet squad did slightly poorer in the first two sessions after the beginning of reduction and their errors are a little larger than found with the control squad up to December 8. The performance of the control squad, however, continues to improve when on the low diet, hence no definite effect is established.

As would be expected, the efficiency in adding one-place numbers gradually improved. The change, however, is remarkably small. When plotted, the curve for total number of columns added in ten minutes is almost a straight line. The most prominent fluctuation is with the control squad on their last normal date, when it so happened that the best adder (a man who had formerly been a bank clerk) was absent from the group work. The percentage of error is larger for the diet squad and contrasts with the other group in that it fails to decline proportionately as much. On the first reduction day (January 13, the men had been on 1400 net calories per day since January 8) for the control squad there was an increase in error.

In strength of grip the diet squad are definitely below the control, but the three reduction dates for the latter squad show no definite change in strength. Therefore the different level between the two squads cannot be interpreted as due entirely to the low diet condition. Unfortunately it was impossible to begin all the tests on the same date, since preliminary instruction required considerable time at the first session, and no normal is here available for the diet squad.

The eye movements, a type of muscular coördination which is peculiarly independent of voluntary control, show for the diet squad a progressive reduction in speed amounting in all to about 5%. The normal performance of the control squad was not regular, which detracts from the significance of the lengthening in the compared two low-diet sessions.

The diet squad made their best score in finger movements on their one normal date, and from this there was a drop of about 6%, which continued irregularly until January 26. The performance of the control squad is fairly even and at a lower level than the normal for the other men and it shows also a decline on the three low-diet dates.

The many extra-laboratory observations of the men, their subjective impressions, and general physical and mental performance are of interest. Statements from the diet squad men were commonly such as these: "I feel fine, except that I notice the cold, am weak in the legs and seem to lack 'pep;' " "I find it best to study immediately after my meals, and when I begin to feel hunger, I occupy myself with the typewriter or other light physical work;" "The reduction in diet would not be hard to undergo if everyone else at the college were doing it." Opposite the impression of weakness in the legs may be set the record of one of the men, who after being on reduced diet for fifty-six days, led a hare and hound race over a course of approximately 8 miles, running the distance in fifty-four minutes, winning the race by eleven minutes. This man stated that he never felt better after a long distance run.

The men are said to have satisfactorily kept up their college work during the period. And while it might be criticised that the work would be judged leniently by those who were watching the experiment, it should be emphasized that the experiments themselves, the bother of complete collection of urine and feces, the many early morning respiration measurements, and the frequent trips to Boston, made a heavy draft on the time and energy of the men, which their fellow students did not have to bear.

On February 1, 1918, eleven of the diet squad were pitted against 11 selected men from the College at Springfield and placed in an arm-holding contest for endurance. The arms were held extended, palms down, at the level of the shoulders. The number of men falling out were practically the same in both squads; as a matter of fact, 7 of the diet squad and 8 in the competing squad were still holding their arms out in the prescribed manner sixty minutes after the trial started. It was not anticipated that the contest would be so long, and other engagements made it necessary to stop at the end of the hour. Whatever one may think of this as a real test of endurance, it is significant that the men who had been on reduced diet for four months were not appreciably inferior.

Basing judgment on the more objective laboratory measurements, in general it must be concluded that a prolonged reduction in diet produces some decline in neuro-muscular activities, but this does not seem nearly as definite nor as large as the changes in metabolism and allied measurements. The psychological changes were not such as to materially interfere with a satisfactory discharge of the common duties of student life.